UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD
2300 Clarendon Boulevard, Suite 1300
Arlington, VA 22201

August 11, 2004

The Honorable John M. Shimkus
House of Representatives
Washington, DC 20515-1319

Dear Mr. Shimkus:

Thank you very much for your written questions related to my testimony on behalf of the Nuclear Waste Technical Review Board at a hearing before the Subcommittee on Energy and Air Quality on March 25, 2004. The Board's answers to the questions are enclosed.

As you know, the Board is charged by Congress with conducting an ongoing and independent review of the technical and scientific validity of activities undertaken by the Secretary of Energy related to the implementation of the Nuclear Waste Amendments Act of 1987.

Please do not hesitate to contact me or have your staff contact Bill Barnard, Board Executive Director, if you have questions related to the Board's responses to your questions.

Sincerely,

David J. Duquette
Chairman, Executive Committee

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Answers to Questions from Representative John M. Shimkus

[On July 28, 2004, the Board sent a letter to the Department of Energy (DOE) conveying the Board's most recent findings on the potential for localized corrosion of waste packages during the thermal pulse due to the deliquescence of calcium chloride brines. These findings affect the issues raised in the following questions. A copy of the letter is attached and is referenced where appropriate in answers to the questions.]

1. In your testimony of March 25, 2004 you referred to the possibility that corrosion could lead to a "breach" or "breaking" of the waste packages proposed for Yucca Mountain. Can you please define what the terms "breach" and "breaking" mean and explain how such occurrences would affect public health and safety?

   Answer:

   By "breach," the Board meant penetration through the outer alloy-22 wall of the waste package. A breach that resulted in complete penetration of the waste package could allow radionuclides to exit the waste package. Many factors could affect radionuclide releases, including the extent and proliferation of corrosion, the amount of water that comes into contact with the corroded waste packages, and the mitigative or transmissive characteristics of the unsaturated and saturated zones. The Board has not conducted its own studies related to the effect on public health and safety of a breach of the waste package. However, the Board has referred to the difficulties inherent in making such estimates in several Board documents.

2. (a) Is this concern based on independent work performed by Board members or just on critique of work put forward by DOE and others? (b) How widely is this concern shared in the scientific community? (c) If available, please cite examples of independent research (by the Board or others) substantiating this concern.

   Answer:

   (a) *In accordance with its mandate established in the Nuclear Waste Policy Amendments Act of 1987, the Board evaluates the technical and scientific validity of the DOE's work related to the disposal, transportation, and packaging of spent nuclear fuel and high-level radioactive waste. Although the Board occasionally undertakes its own focused analysis of specific issues, the Board does not conduct experimental research directly. In reaching the conclusions in its October 2003 letter and November 2003 report on the potential for localized corrosion during the thermal pulse, the Board used the DOE's testing conditions and data on potential repository tunnel environments.*

On the basis of its interpretation of DOE and other data, the Board concluded that deliquescence-induced crevice corrosion would likely be initiated during the higher-temperature period of the thermal pulse. That conclusion was based particularly on corrosion tests conducted in an aqueous environment rich in calcium chloride. Test results showed clearly that corrosion would take place in that environment when temperatures range roughly between 140°C and 160°C. The results also suggested that the expected mitigating effect of the presence of nitrate ions might not be sufficient to inhibit the corrosion process fully.

However, as stated in the Board's July 2004 letter to the DOE, primarily on the basis of information presented at the Board's May 2004 meeting, it appears unlikely that dust that accumulates on waste package surfaces during the preclosure period would contain significant amounts of calcium chloride or that significant amounts of calcium chloride would evolve on waste package surfaces during the thermal pulse. Consequently, the calcium chloride-rich environment selected for corrosion tests does not appear representative of the conditions that can be expected on waste package surfaces in a Yucca Mountain repository. If calcium chloride is not present, calcium chloride-rich brines will not form by deliquescence, and crevice corrosion due to the presence of such brines in the temperature range of roughly 140°C to 160°C will not occur. Thus, the Board concludes that deliquescence-induced localized corrosion during the higher-temperature period of the thermal pulse is unlikely.

The Board is pleased that the DOE conducted the additional research needed to resolve this extremely important corrosion issue. However, this does not mean that the Board believes that all uncertainties related to corrosion of waste packages have been addressed. For example, in its July 2004 letter, the Board noted other corrosion issues that the Board believes require additional analysis, including (1) a possibility that when temperatures in repository tunnels fall below boiling, localized corrosion could occur in concentrated sodium chloride solutions; (2) the possible presence of ammonium ion and the implications of its presence for corrosion; and (3) the potential for nitrates to be aggressive corrodents in some circumstances. The Board believes that it is important to continue corrosion testing aimed at addressing uncertainties.

***(b)** The conclusion stated in the Board's October 2003 letter and November 2003 report that localized corrosion would likely be initiated if waste package surface temperatures were above 140ºC and if concentrated brines such as would be formed by the deliquescence of calcium chloride were present is consistent with research conducted by others in the scientific community.*

***(c)** Transcripts from the Board's May 2003, September 2003, and May 2004 meetings, which include information from several sources used by the Board to reach the conclusions in its October 2003 letter, its November 2003 report, and its July 2004 letter, are posted on the Board's Web site: www.nwtrb.gov.*

3. The fall 2003 letter and report you referred to in your testimony concludes that very aggressive chemistry conditions are likely to exist on the waste package surfaces during the thermal period. (a) In reaching this conclusion, has NWTRB considered the potential for mitigating factors that could make the chemical conditions more benign? (b) Specifically has the board considered the possibility of significant volatilization and removal of chloride in postulated brines as hydrogen chloride (hence reducing the likelihood of high chloride concentrations), the mitigating effects of the presence of aluminosilicate minerals associated with dust in the repository tunnels (and the ability to such minerals to buffer pH values), or scenarios in which conditions would cause the corrosion process, if initiated, to stifle rather than penetrating deep into the waste package material? (c) What is the board's view of these possibilities? Please explain.

   Answer:

   (a,b,c) *In reaching the conclusions presented in its October 2003 letter and November 2003 report on the potential for localized corrosion during the thermal pulse, the Board used the DOE's testing conditions and data on potential repository tunnel environments.*

   As explained in the answer to question number 2a, it appears unlikely that the dusts in repository tunnels will contain significant amounts of calcium chloride during the thermal pulse. The factors discussed in question 3 that might mitigate the effects of calcium chloride are therefore moot.

4. (a) Do the conclusions that you reached regarding the environment within the proposed repository and the potential impact on the waste packages take into account the need for a confluence of conditions to occur before the waste packages would be adversely impacted? (b) Has the Board specifically evaluated the probability of these conditions occurring? (c) Has the Board taken into account the time dependency of these conditions and what, specifically, is the likelihood that such conditions would occur along the time line required for this to be a concern? (d) Please explain, in detail, these evaluations and results.

   Answer:

   (a) *The Board stipulated that a combination of factors would be necessary for the initiation of deliquescence-induced localized corrosion. Specifically, the Board said that if waste package surface temperatures were above 140ºC and if concentrated brines such as would be formed by the deliquescence of calcium chloride were present in repository tunnels, localized corrosion would likely be initiated.*

   (b,c) *The Board has stated that on the basis of information presented at its May 2004 meeting, it appears unlikely that the dust in repository tunnels will contain significant amounts of calcium chloride during the thermal pulse. Consequently, as discussed above, deliquescence-induced localized corrosion of the waste packages is unlikely*

during the thermal pulse. However, the Board also stated in its July 2004 letter that the extent to which the DOE has characterized accurately the likely waste package environments is unclear at this point. The DOE's characterization of repository and waste-package environments will continue to be a major focus of the Board's technical and scientific review.

***(d)** The Board's evaluation is based on basic technical and scientific analysis, its own expert judgment, and research and analysis presented at Board meetings by the DOE and others.*

5. Does the Board accept the mandate (per NRC regulation 10 CFR Part 63) that the repository safety analysis must be probability-based?

   Answer:

   The Board's mandate is to review the technical and scientific validity of DOE activities. The Board's purview does not include policy or regulatory matters. The Board understands that performance estimates are probability based; however, the Board has stated consistently that the DOE's safety case could be strengthened by supplementing repository performance estimates with other lines of argument or evidence—an approach taken by other countries with nuclear waste disposal programs. The result could be increased confidence in the DOE's performance estimates.

6. (a) DOE has conducted total system performance assessments of Yucca Mountain that indicate, even if the waste package fails during the thermal period, the radiological consequences to the public will be a small fraction of the dose limit set forth in EPA and Nuclear Regulatory Commission (NRC) regulations. (b) Yet the NWTRB maintains that a costly design change (to maintain the repository temperature below boiling conditions at all times) needs to be made to prevent such a failure. (c) What safety analysis has NWTRB conducted to indicate that proceeding with the current design has a significant impact on public health and safety? (d) Alternately, what safety analysis has NWTRB conducted to indicate that such a design change will significantly enhance public health and safety? (e) Is NWTRB aware of analyses by NRC indicating that the formation of corrosive brines is independent of repository design temperature? What is NWTRB's view of this analysis?

   Answer:

   ***(a)** Estimates of radiological consequences due to waste package failure are highly dependent on underlying assumptions. At the Board's September 2003 meeting, the DOE presented simplified studies suggesting that under one set of assumptions, failure of the waste packages could result in exceedence of the dose limit; using different assumptions, the DOE calculated that the repository would meet the regulatory standard if the waste packages failed.*

*(**b,c,d**) The Board noted in its November 2003 report that data currently available indicate that perforation of the waste packages caused by localized corrosion is unlikely if waste-package surface temperatures are kept below 95°C. The Board has not conducted its own studies related to the effect on public health and safety of the DOE's current repository design; the Board's concerns have centered on avoiding potential problems with a major barrier (i.e., the waste package). The Board has stated many times and still believes that there are significant uncertainties associated with the high temperatures in the DOE's current repository design and that keeping temperatures below boiling in repository tunnels could decrease uncertainties and increase confidence in repository performance estimates. According to a 2002 DOE white paper on thermal operating modes, it is not clear that a low-temperature design would be significantly more costly in the long run than a high-temperature design.*

*(**e**) Data from the DOE and the NRC indicate that some corrosive brines could exist below 95°C. In its July 2004 letter, the Board requested that the DOE examine the likelihood that such brines might form and the mechanisms that might lead to the formation of such brines.*

7. (a) Is the Board cognizant of the significant expertise of the NRC and its consultants in this area and (b) is the Board prepared to accept NRC's findings regarding whether or not the DOE approach is safe and consistent with regulatory requirements?

   Answer:

   *(**a**) Yes.*

   *(**b**) The Board recognizes that the NRC has responsibility for a regulatory finding related to safety and consistency with regulatory requirements. The Board's statutorily established mandate is to evaluate the validity of technical and scientific activities undertaken by the Secretary of Energy and to make recommendations to the Secretary of Energy and Congress. The Board's purview does not include reviewing NRC activities or findings.*